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## Food Measurements and Equivalents

Cooperative Extension

*South Dakota State University*

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Website: [extension.sdstate.edu](http://extension.sdstate.edu)

Phone: 605-688-4792

Email: [sdsu.extension@sdstate.edu](mailto:sdsu.extension@sdstate.edu)

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## Know Your Fertilizer

### PLANT NUTRIENTS

Of all the elements found in any plant by chemical analysis, at least 14 are required and necessary for the plant to grow properly. These essential plant elements are: carbon, hydrogen, oxygen, nitrogen, sulfur, iron, manganese, boron, zinc, copper, phosphorus, potassium, calcium, and magnesium.

The first three—carbon, hydrogen and oxygen—are taken up by the plant from carbon dioxide in the air and from water. Normally the supply of these elements presents no problem.

Nitrogen, phosphorus, and potassium, known as **primary elements**, are required in rather large amounts and of all of the nutrients are most likely to be deficient or lacking in a plant. These nutrients are supplied by the soil. Nitrogen is available to plants in two forms—ammonium and nitrate salts. Phosphorous and potassium are available in the forms of soluble phosphate and potassium salts.

The remaining elements are known as **secondary elements** either because the supply in the soil is generally sufficient or because they are needed in such small amounts. Calcium, magnesium, and sulfur, even though necessary for plant growth, are most often applied to soil not to overcome a nutrient deficiency but to modify some other soil condition that is limiting plant growth. Consequently, these elements may be referred to as **amendments**.

Iron, manganese, boron, zinc, and copper are needed in minute quantities for plant growth and often are referred to as **trace or minor elements**.

### NUTRIENT EFFECTS ON PLANT GROWTH

The 14 elements which are essential to plant growth contribute certain metabolic effects. Some of these effects in the development and growth of plants relative to the primary elements are as follows:

#### Effects of Nitrogen

Encourages above-ground vegetative growth.

Causes a deep-green color by increasing chlorophyll.

Increases plumpness and protein of grain.

Produces succulence in crops such as the grasses.

**NOTE:** A deficiency of nitrogen results in stunted plants with restricted root systems. The basal leaves of the plant turn yellow or yellowish green down the midrib toward the tip. Yields and quality are reduced.

#### Effects of Phosphorus

Encourages root growth, especially the lateral and fibrous rootlets.

E. J. Williamson Extension Soil Specialist

# Know Your Fertilizer

*Cooperative Extension Service*



Hastens maturity of the crop; flowering and fruiting depend on it.

Increases the yield ratio of grain to straw as well as total yield of grain.

Improves quality of crops.

Increases disease resistance.

**NOTE:** A deficiency of phosphorus results in retarded growth; lower leaves sometimes yellow between veins but more often are purplish, particularly the leaf stem. Leaves drop prematurely with remaining foliage possessing a sickly dark green shade.

#### Effects of Potassium

Improves the vigor of plants.

Increases resistance to disease.

Encourages root formation.

Delays maturity, thus balancing the effect of phosphorus.

Gives plump, heavy kernels to grain.

Necessary for tuber development.

Necessary in the development of chlorophyll.

Necessary for starch formation.

**NOTE:** A deficiency of potassium affects normally the older, lower leaves of plants. The lower leaves are mottled, with dead areas near the tips and margins. A yellowish mottling begins at margin and continues toward center with margins later becoming brown, curving under and older leaves dropping.

As is noted most of the primary elements as well as the other essential elements tend to check, balance, support, and supplement one another in their metabolic effects on plant growth. All these elements be present and available in the soil and their supply must be in balance with one another as well. Because crops

remove large quantities of the primary elements—nitrogen, phosphorus, and potassium—these elements often become deficient in soils and cause an unbalanced soil nutrient condition. Fertilizer treatments, then, are made to increase the supply and availability of elements necessary for the growth of plants and microorganisms in the soil, and to establish a proper balance between the essential elements. Often the addition of only one or two nutrients is necessary to produce this so-called balance.

#### FERTILIZER TERMS AND DEFINITIONS

**Fertilizer.** Any natural or manufactured material added to the soil to supply one or more plant nutrients. The term is generally applied to largely inorganic materials other than lime or gypsum (mineral fertilizers) sold in the trade.

**Carrier.** Any material used in the manufacture of fertilizers selected because of its specific nutrient, availability, physical characteristics, and the cost of the plant nutrients contained. A material possessing only one plant nutrient is classed as a single carrier (ammonium nitrate, muriate of potash, treble superphosphate, etc.) while other carriers may contain two or even all three of the major plant nutrients.

**Fertilizer Analysis.** The chemical analysis of the nutrients of a fertilizer on a percentile basis or the statement of the quality of the fertilizers. It is determined by laboratory methods based on the solubility of the nutrients in specified solvents under closely defined conditions.

- Nitrogen fertilizers commonly are marketed on the basis of **total nitrogen** content (N), the form of the nitrogen being listed as ammonium, nitrate, organic, etc.
- Phosphorus fertilizers usually are evaluated on the basis of the quantity dissolved in successive extractions of the sample with water and neutral ammonium citrate solution. The soluble phosphorus determined in this manner is considered to be readily usable by plants and commonly is designated as **available phosphorus** ( $P_2O_5$ ).
- Potassium fertilizers are marketed on the basis of **soluble potash content** ( $K_2O$ ).

**Fertilizer Grade.** An expression that indicates the percentage of plant nutrients in a fertilizer. Thus a 11-48-0 grade contains 11% total nitrogen (N), 48% available phosphoric oxide ( $P_2O_5$ ), and 0% potash ( $K_2O$ ). This convention is in common use even though the nitrogen, phosphorus, and potassium are present in other forms.

**Fertilizer Ratio.** The ratio existing between percentages of nitrogen, phosphoric oxide, and potash

found in a fertilizer. For instance, a 6-24-0 or 8-32-0 grade would have a 1-4-0 ratio.

**Unit of Plant Nutrients.** One percent of the available plant nutrients on the basis of a ton of fertilizer. Thus one unit equals 20 pounds of plant nutrients. The chemical analysis quoted on any fertilizer is really a statement of the number of units carried to the ton. For example, superphosphate with 20% available phosphoric acid has 20 units or 400 pounds of available phosphoric acid.

#### SOURCES AND FORMS OF COMMON COMMERCIAL FERTILIZERS

The application of commercial fertilizers to soils is primarily to supply plant nutrients. Fertilizer applications should be considered as a supplement to the nutrients already in the soil rather than as the sole source of supply.

Assuming nitrogen alone is needed for a certain soil, the following factors should be kept in mind. There are several carriers of nitrogen on the market. Some possess relatively small amounts of nitrogen while others are high carriers. Various nitrogen fertilizers on the market do not react the same in a given soil. Nitrogen in the ammonium and nitrate forms is immediately available for plant use. The nitrogen of non-synthetic organic carriers must be released by soil micro-organism activity before availability for plant use is accomplished. Other types of nitrogen forms may make soils more acid or become alkaline and create a breakdown in the physical condition of the soil.

##### Carriers of Nitrogen

**Ammonium Sulfate.** This fertilizer is made by passing ammonia gas through sulfuric acid and evaporating to dryness. The ammonia is in part a by-product from coke ovens and gas plants and in part a product of chemical synthesis. This inorganic crystalline salt is usually white or grayish in color and very soluble in water. It contains about 20% nitrogen (plus about 24% sulfur). When this fertilizer is applied to South Dakota soils much of the ammonium rapidly changes into the nitrate form. Both ammonium and nitrate forms of nitrogen are readily used by plants. Ammonium sulfate tends to increase the acidity of soils when used in large amounts or over a period of years.

**Ammonium Nitrate.** This product is a crystalline inorganic salt manufactured synthetically. The pure salt is white, but it usually appears on the market as a brown or orange granulated material which has been treated to prevent absorption of water from the air and to make it easier to apply by drilling. It carries 33.5%. About half the nitrogen is in the form of ammonium and about half in the form of nitrate.

This fertilizer is water soluble and tends to reduce soil alkalinity. It is a quick fertilizer, being available to plants as soon as applied.

**Urea.** Urea is a synthetic fertilizer, the nitrogen being carried in an organic form. It is a white or gray crystalline product carrying about 46% nitrogen. Urea is completely soluble in the soil water, and the nitrogen is converted rapidly into the ammonium form and finally into nitrate.

**Nitrogen Solutions.** Nitrogen solutions are composed of materials prepared in "liquid" form including anhydrous ammonia and combinations of ammonia, ammonium nitrate, sodium nitrate, and urea dissolved in water. Combining these materials by the manufacturer produces vapor pressures which determine the type of equipment required to store, handle, and apply the solutions. This results in the general classification of nitrogen solutions into **high-pressure, low-pressure, and non-pressure types.**

**High-Pressure Solutions (Anhydrous Ammonia)**—A liquified gas containing 82% nitrogen. When compressed under suitable conditions of pressure and temperature, ammonia assumes a liquid form which is stored and shipped in pressure tanks. While it is used mostly in the fertilizer manufacturing industry, direct application to the soil as a source of nitrogen is being practiced. For direct application, the soil should be moist and the gas knifed at least 6 inches below the soil surface. Otherwise, considerable loss of nitrogen to the atmosphere will result.

**Low-Pressure Solutions.** A liquid containing from 20 to 41% nitrogen. Part of the nitrogen is anhydrous ammonia dissolved in water, and the rest of the nitrogen consists of materials such as ammonium nitrate and urea when the nitrogen content is above 26%. These solutions carry a low pressure of about 15 pounds and must be knifed 2 to 3 inches into the soil.

**Non-Pressure Solutions.** A non-pressure liquid containing from 28 to 32% nitrogen. The solutions are composed of ammonium nitrate and urea dissolved in water. About one-fourth of the nitrogen is in the nitrate form, one-fourth is ammonium; and the remaining half is urea nitrogen. Having no pressure, the solutions can be applied on the surface of the soil by dribbling or spraying without loss of nitrogen.

**Non-Synthetic Organics.** When a slow acting delayed source of nitrogen is required, such as for greenhouse purposes, by-products as tankage, sewage sludge, guano, and dried blood are useful. These nitrogen materials must be converted into available ammonium and nitrate salts by soil micro-organisms

action before nutrient usefulness for plant growth prevails.

#### Carriers of Phosphorus

**Rock Phosphate.** Phosphate rock is found in natural deposits in many parts of the world. It varies in purity and is found in many different forms. The principal constituent is fluorapatite, although it is usually expressed for convenience as tricalcium phosphate, and is insoluble.

The rock phosphate on the commercial market is the raw natural occurring material in ground form. This material is a heavy, finely ground powder of a light color. It generally carries from 20 to 35% total phosphoric acid ( $P_2O_5$ ). However, less than 5% is available phosphoric acid. This material for soils of South Dakota is not recommended.

**Superphosphates.** Superphosphate is raw rock phosphate that has been treated with acids to convert the phosphorus into forms more available to plants. It appears on the market as a gray powder or in granular form. It has a high degree of availability and is acid, although it has but little effect in changing the alkalinity of the soil. Several grades of superphosphate are on the market, the two most common carry 16 to 20% available phosphoric acid (superphosphate) and 40 to 45% available phosphoric acid (treble superphosphate).

**Calcium Metaphosphate.** This is a relatively new product made by treating rock phosphate with hot  $P_2O_5$  from a phosphorus burner, which forms liquid metaphosphate. After this liquid is solidified by cooling, it is ground and marketed. This fertilizer is a high analysis material carrying 62 to 63% available phosphoric acid ( $P_2O_5$ ). Its fertilizing value in contrast with superphosphate has not been thoroughly tested in South Dakota, although preliminary tests indicate this material to be equal in response to that of treble superphosphate.

#### Carriers of Potassium

**Potassium Chloride (Muriate of Potash).** This is a high-grade fertilizer material varying from 48 to 62% water soluble potash ( $K_2O$ ). It is a white, crystalline, naturally occurring salt, neutral and readily available.

**Potassium Sulfate (Sulfate of Potash).** This is a high-grade fertilizer material varying from 48 to 50% water-soluble potash ( $K_2O$ ). It is a white crystalline, naturally occurring salt, neutral and readily available.

#### Mixed Fertilizers

Mixed fertilizers contain at least two and often all three of the primary plant nutrients—nitrogen, phos-

phorus and potassium. They are available today both in the dry and liquid formulations.

**Dry mixed fertilizers** are manufactured either by combining single carriers and mixtures to obtain a desired analysis, or by chemically uniting ammonia with single and mixed carriers. Ammoniated carriers are designated as **ammoniated mixtures**. For example, when superphosphate is ammoniated, it is known as **ammoniated phosphate**. Common analysis of some of the ammoniated dry carriers include 16-20-0, 10-20-0, 10-20-10, 15-15-0, etc. When ammonia is combined with phosphoric acid solutions and dried, a mixed fertilizer called **ammonium**

**phosphate** results. These fertilizers possess higher phosphorus contents than the ammoniated phosphates and normally are obtained in either a 1-3-0 or 1-4-0 ratio. Examples commonly on the market include such grades as 11-48-0, 13-39-0, 16-48-0, 21-52-0, etc.

**Liquid mixed fertilizers** are receiving increasing attention and appear to be well adapted, as starter fertilizers. A wide variety of grades can be manufactured; however, solubility characteristics and salting-out limit production of some of the higher analysis grades. In general, the upper limit is about 30% plant nutrients.